Transformations

Reporting Category	Reasoning, Lines, and Transformations	
Topic	Identifying translations, reflections, rotations, and dilations of polygons	
Primary SOL	G.3d	The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.
Related SOL	G.3c, G.6, G.14	

Materials

- Transformation Cards (attached)
- Scissors
- Activity Sheet (attached)
- Graph paper
- Rulers
- Paper clips or zip top plastic bags

Vocabulary

similar, translation, reflection, rotation, dilation, transformation, scale factor, x-axis, y-axis, origin, coordinates, vertex (earlier grades)

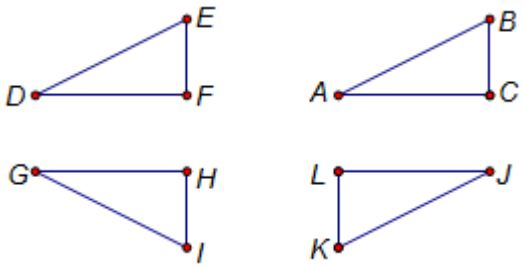
dilation factor, image, pre-image (G.3d)

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

1. As an introduction, use a presentation found on the Internet by searching for "transformations symmetry presentation." Students may need to be reminded about the graphs of the lines $y = x$, $y = -x$, $y = 0$, $x = 0$, $y = k$, and $x = k$.
2. Distribute scissors and copies of the Transformation Cards, and have students cut out the cards.
3. Have students work in small groups to match each graph with the description of the transformation. Students can do this either with all the cards face up or as a concentration game.
4. Have students discuss findings with their partners.
5. Discuss findings as a whole group.
6. Have students work in small groups to complete the Activity Sheet.
7. Have students discuss findings with their partners.
8. Discuss findings as a whole group.

Assessment

- **Questions**
  - In the diagram below, $\Delta ABC \cong \Delta DEF \cong \Delta GIH \cong \Delta JKL$.



    What transformation maps ΔABC onto ΔDEF? ΔDEF onto ΔGIH? ΔDEF onto ΔJKL? ΔABC onto ΔJKL? How could you map ΔABC onto ΔGIH?
  - ΔMNO has the vertices $M(0, 3)$, $N(3, 2)$ and $O(2, 1)$. ΔPQR is a translation of ΔMNO and P is the point $(-1, 0)$. What are the coordinates of Q and R?
  - ΔSTU is a reflection of ΔABC across the x-axis. What are the coordinates of S, T, and U?
  - ΔVWX is a 90° clockwise rotation of ΔMNO about the point A. What are the coordinates of W?
  - ΔMYZ is a dilation of ΔMNO by a factor of 2. (Notice that both triangles contain the same point M, which is the center of dilation. What are the coordinates of Y?
- **Journal/Writing Prompts**
  - Complete a journal entry summarizing the activity.
  - Describe real-world examples of translations, reflections, rotations, and dilations.
  - Describe in your own words each of the transformations we have studied.
- **Other**
  - Have each group present their findings to the class.
  - Have students use a figure to demonstrate each of the four types of transformation.

Extensions and Connections (for all students)

- Students can create a design, such as a tessellation or quilt design, and describe the transformations in their design.
- Students can explore tools used for drawing enlargements.
- Students can practice transformations (especially translations) using graphs of circles in the coordinate plane.
- Show students graphs of quadratic equations such as $y = x^2$, $y = -x^2$, $y = x^2 + 1$, $y = x^2 - 2$, and $y = (x - 1)^2$, and ask what transformations map the graph of $y = x^2$ onto each of the other graphs.
- Use a graphic of triangular numbers to illustrate dilations.
- Have students take pictures or find images that illustrate transformations on the Internet.

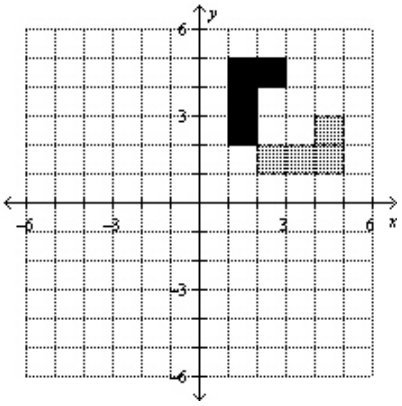
Strategies for Differentiation

- Depending on the needs of students, cut out the Transformation Cards in advance.

- Depending on the level of students, introduce the vocabulary before students start the activity.
- Depending on the level of students, work through a couple of examples with the class before they complete the activity.
- Have students draw and cut out a figure and use that figure to demonstrate the types of transformations (except dilations.) Then have them draw and label an example of each type of transformation of their figure.
- Use patty paper to explore different types of transformations.
- Use mirrors or image reflectors to explore reflections.
- Use physical objects to concretely demonstrate various transformations. Magnets on the back of shapes on the board work well.

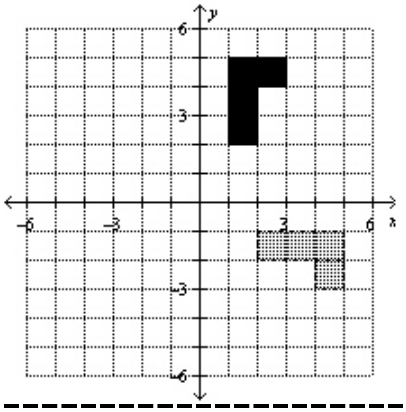
Transformation Cards

Cut out the cards on the dotted lines.

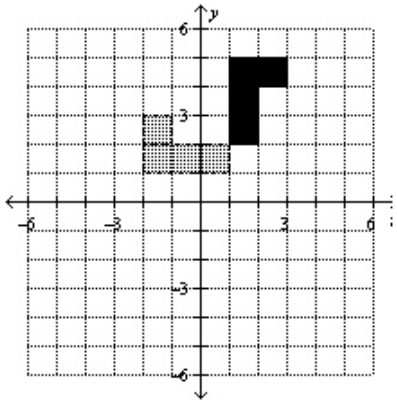


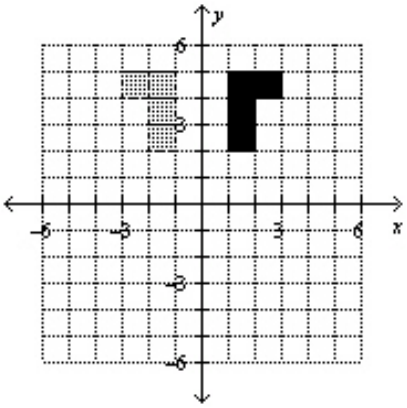
Rotation of  90 degrees counterclockwise about the point (1, 2)

Reflection of  across the line $x = 0$

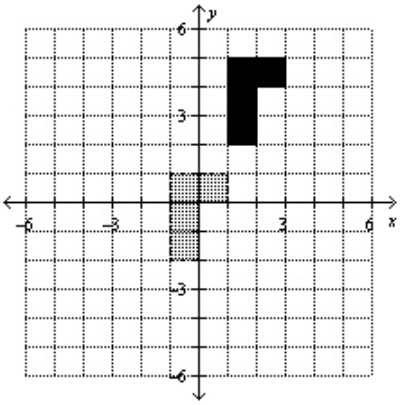


Rotation of  90 degrees clockwise about the origin



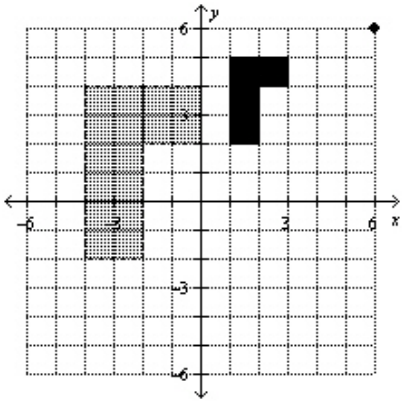


Reflection of
across the line $y = x$

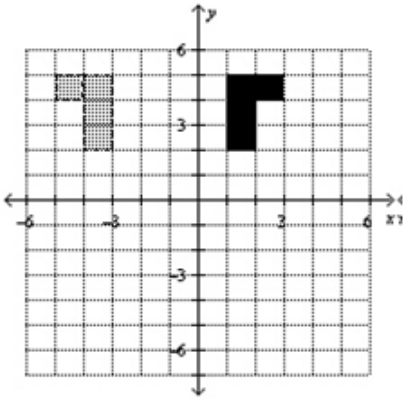


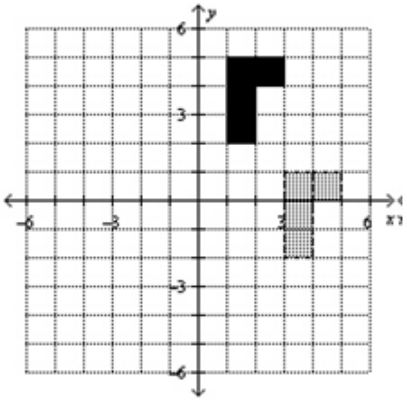
Reflection of
across the line $x = -1$

Reflection of
across the line $y = -x$

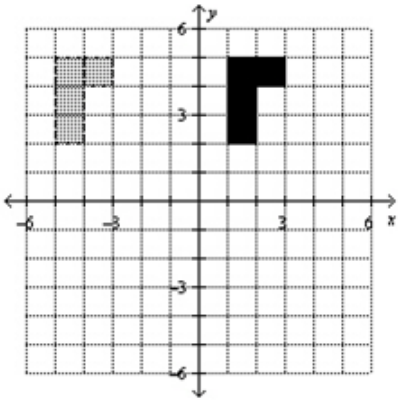


Reflection of
across the x-axis



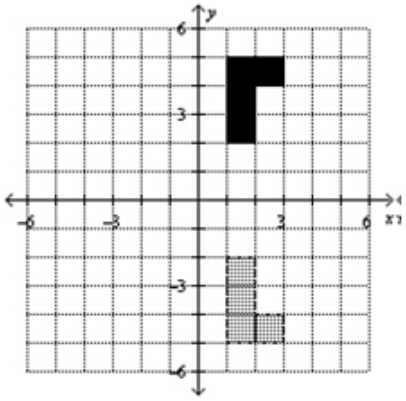


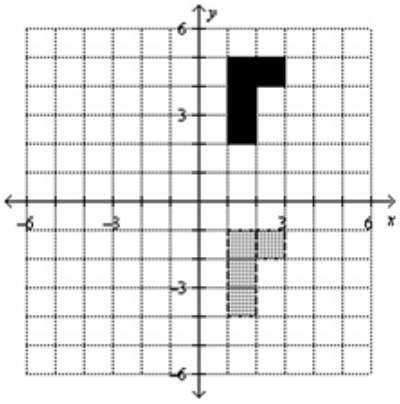
Translation of
6 units down



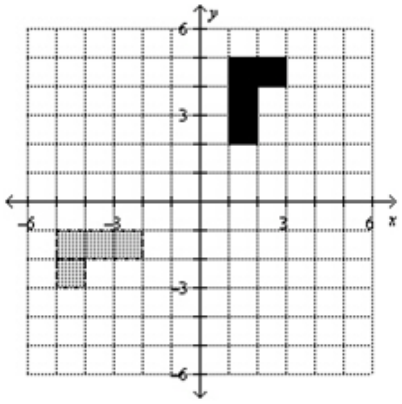
Translation of
4 units down and
2 units to the left

Dilation of
by a factor of 2





Translation of
6 units to the left



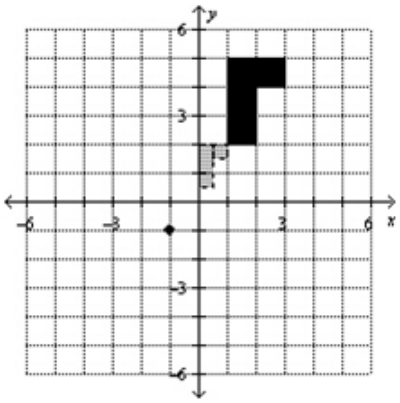
Dilation of 

by a factor of $\frac{1}{2}$

Translation of 

4 units down and

2 units to the right



Activity Sheet: Transformations

Name _____ **Date** _____

1. Plot the points *A* (1, 1), *B* (5, 1), *C* (6, 4), and *D* (2, 4) on a coordinate plane.
2. Translate *ABCD* six units left and six units down. Label the vertices of the translated image *A*′, *B*′, *C*′, and *D*′.
   a) Rotate *A*′*B*′*C*′*D*′ 180° about the origin, and label the vertices (ordered pairs).
   b) Rotate *A*′*B*′*C*′*D*′ 90° about the point *A*′, and label the vertices.
   c) Reflect *A*′*B*′*C*′*D*′ through the *x*-axis, and label the vertices.
   d) Reflect *A*′*B*′*C*′*D*′ through the line $x = -2$, and label the vertices.

3. Draw the pentagon *ABCDE* with vertices *A* (−3, 3), *B* (0, 6), *C* (6, 3), *D* (6, −3), and *E* (0, −6) on coordinate graph paper.
   a) Multiply the coordinates of the vertices by each of the following numbers: $\frac{1}{3}, \frac{2}{3}, \frac{4}{3}, \frac{5}{3}, 2$ and complete the table below.

Dilation Factor	*A* (−3, 3)	*B* (0, 6)	*C* (6, 3)	*D* (6, −3)	*E* (0, −6)
$\frac{1}{3}$	(−1, 1)				
$\frac{2}{3}$					
$\frac{3}{3}=1$	(−3, 3)	(0, 6)	(6, 3)	(6, −3)	(0, −6)
$\frac{4}{3}$					
$\frac{5}{3}$					
$\frac{6}{3}=2$					

   b) Graph each of the five dilations of the pentagon *ABCDE* on the same graph with *ABCDE*.
   c) What do you notice about the ordered pairs (look at the columns) and the six pentagons?